X-623-63-137
TM X-55114

ADVANCED ORBITING SOLAR OBSERVATORY DEVELOPMENT TASKS

SECOND REVISION DECEMBER 2, 1964

NASA

GODDARD SPACE FLIGHT CENTER

GREENBELT, MARYLAND

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1.0 PHASE I EXTENSION REQUIREMENTS

1.1 General

The contractor is required to perform the necessary efforts leading to the development and fabrication of the Advanced Orbiting Solar Observatory. Work performed by the contractor shall be in accordance with the requirements outlined within this document and the restraints of the preliminary AOSO Specification X-623-63-136, dated 1 October 1963. By definition, Phase I is the time period November 18, 1963 to November 17, 1964; and Phase I Extension (IA) is the time period November 18, 1964 to May 17, 1965. The effort performed by the contractor during Phase I was defined in Contract NAS5-3587, GSFC document X-623-63-137 as revised 9 September 1963, and Technical Directives (TD's) issued by GSFC. Revisions to document X-623-63-137, which pertain to Phase I effort are dated 9 September 1963, 2 October 1963, 14 February 1964, 26 March 1964, and 20 May 1964. The TD's issued by GSFC, of which some are revisions to X-623-63-137, are TD-1 (dated 19 November 1963), TD-2 (19 November 1963), TD-3 (18 May 1964), TD-4 (19 May 1964), TD-5 (20 May 1964), TD-6 (2 June 1964), TD-7 (3 June 1964), TD-8 (5 June 1964), and TD-9 (6 July 1964). Phase IA was initiated by a letter extension of the contract NAS5-3587 dated 17 November 1964, and is further defined by this document. To provide clarity, the Phase I tasks have not been printed in this revision; and the incomplete, continuing, and associated tasks from Phase I have been rewritten below to make up a complete Statement of Work for Phase IA.

1.2 Objectives

The major objectives of the effort outlined in this document are as follows:

(A) Concentrate on the solution of critical problems, for example Fine Sun Sensor, and in-orbit alignment stability.

(B) Hold intact key members of the development teams which have been established at both the contractor's and major subcontractors' facilities.

(C) Further define the observatory requirements.

(D) Prepare for system breadboard integration tests.

(E) Develop an observatory design configuration which provides the best compromise between performance, reliability, cost, and development schedule.

(F) Minimize the number of alternate approaches or design changes for consideration in the Phase II program should it be authorized.

1.3 Design and Development Procedures

1.3.1 The contractor shall utilize, to the maximum extent practical, all previous studies and analyses leading to the development of the AOSO.

1.3.2 The contractor shall utilize, to the maximum extent practical, existing equipments and components (such as those from OGO and OAO programs) consistent with performance, cost, scheduling, and reliability requirements of the AOSO program.

1.3.3 The contractor may propose task modifications, or additional tasks, that are required for the successful completion of the Phase IA objectives. Those modifications, or additional tasks, proposed by the contractor shall be submitted in writing for GSFC approval before initiation of contractor's action.

1.3.4 Individual test plans for each test required by this document shall be submitted in memorandum form to GSFC for approval at least one month prior to the start of the test. Test procedures shall be submitted to GSFC at least two weeks prior to the start of the test.

1.3.4.1 A test plan shall consist of:

(A) A list of all test objectives.

(B) A summary outline of the test methods and approach (including calibration) in sufficient detail to indicate how the objectives of the test will be met.

(C) A list of required support equipment (including instrument accuracies).

(D) Estimates of the measurement accuracy requirements which meet the test objectives.

(E) A discussion of likely catastrophic failures or occurrences which could destroy the item being tested or invalidate the test or test data.

1.3.4.2 Test Procedures shall consist of:

(A) The detailed step by step procedures, including calibrations, needed to perform the test.

(B) An operational plan, delineating each individual's duties, wherein the test requires many people to perform it.

(C) A data reduction plan for those tests which generate a large amount of data, and require data reduction prior to proceeding with subsequent phases of the test.

1.4 Correlation Between Phase I and Phase IA Tasks

New (Phase IA) X-623-63-137 Rev. Task No.	Present (Phase I) X-623-63-137 Continuing from Task No.
1.1	1.1
1.2	1.2
1.3	1.3
2.5	2.1
2.6	2.2
2.7	Para. 3.5.4 (Document X-623-63-136)
2.8	2.3
2.8.2.1	4.2.11
2.8.2.2	4.3.5
2.8.2.3	4.1.15
2.8.2.4	4.4.4
3.7	3.1.6
3.7.1	Associated
3.7.2	3.1.5
3.7.3	4.2.3.3
3.7.4	3.2.2 & 3.2.4
3.7.5	3.1.1
3.7.6	3.3
3.7.7	1.2.1
3.7.8	4.1.1
3.7.9	3.1.2
3.7.10	3.2.1
3.7.11	Associated
3.8.1	1.1
3.8.2	3.3.2 & 3.4.1
3.8.3	3.4.1
3.9.1	3.2.1 & 3.2.3
3.9.2	3.2.2
3.9.3	3.2.4
3.10.1	3.4.2
3.10.2	3.4.4
4.1.18	4.1.5
4.1.19	4.1.6
4.1.20	4.1.7
4.1.21	4.1.9
4.1.22.1	4.1.8
4.1.22.2	4.1.12
4.1.22.3	4.1.12
4.1.22.4	4.1.12
4.1.23	4.1.15
4.2.16.1	4.2.9
4.2.16.2	4.2.10
4.2.16.3	Associated
4.2.16.4	4.2
4.2.16.5	4.2.8
4.2.17.1	4.2.1
4.2.17.2	4.2.1

New (Phase IA) X-623-63-137 Rev. Task No.	Present (Phase I) X-623-63-137 Continuing from Task No.
4.2.17.3	4.2.13
4.2.17.4	Associated
4.2.18.1	4.2
4.2.18.2	Associated
4.2.19.1	4.2
4.2.19.2	Associated
4.2.20.1	4.2
4.2.20.2	Associated
4.2.21.1	4.2
4.2.21.2	Associated
4.2.22.1	4.2
4.2.22.2	Associated
4.2.23.1	3.1.6.5 (TD-8)
4.2.23.2	4.2
4.2.23.3	Associated
4.2.24.1	4.2
4.2.24.2	Associated
4.2.25.1	3.1.6.4 (TD-7)
4.2.25.2	Associated
4.2.26.1	3.4.4.2
4.2.26.2	3.4.4.2
4.2.26.3	3.4.4.2
4.2.27	4.2.5
4.2.28	4.2.11
4.2.29	2.2
4.3.7.1	4.3
4.3.7.2	Associated
4.3.7.3	Associated
4.3.7.4	4.3.1.2.1 (Cancelled by Mod. 2. to NAS5-3587)
4.3.8.1 through 4.3.8.6	Associated
4.3.8.7	Associated
4.3.9	4.3
4.4.5.1	4.4.1.3
4.4.5.2.1	4.4.1.4 & 4.4.1.5
4.4.5.2.2	4.4.1.3
4.4.5.3	4.4.2.2 & 4.4.2.3
4.4.5.4	4.4.3
4.4.6.1	4.4
4.4.6.2	4.4
4.4.6.3	Associated
4.4.6.4	4.5
4.4.6.5	4.4.4
4.5.1	3.4.4
4.5.2	3.4.4.3
4.5.3	4.5 & TD-3
4.5.4	3.4.2
4.5.5	4.5
4.5.6	3.4.2
4.6	3.4.7

2.0 MANAGEMENT PROCEDURES

Paragraphs 2.1 through 2.4, which were Phase I tasks, have been deleted from this document. All incomplete, continuing, and associated effort from Phase I has been rewritten into the Phase IA tasks given herein.

2.5 Management

The NASA system for program control in the NASA PERT and Companion Cost Handbook, dated 30 October 1962, shall be applied to the AOSO program.

2.5.1 The Phase IA efforts require a separate activity/event network for the new tasks in addition to the revision to the Phase I networks such that the Project Manager, in association with the PERT Analyst, can effectively analyze the true progress and status of the individual phases of the project.

2.5.2 The financial data reporting system established during Phase I is to continue during Phase IA. The contractor shall prepare, maintain, and submit cost curves by subsystems and related areas. These curves are to be a continuation of the Phase I charts (where applicable) projected to the new level of effort in such a manner that the account number structure will permit a rapid and accurate analysis of the true picture of the over-all costs of each work package. These curves shall show cumulative planned and actual expenditures for: (a) manhours by work package, (b) planned total costs by work package. All curves will be based on accrued costs (no commitments). In addition, summary charts for the project in accordance with (a) and (b) above shall be incorporated.

2.6 Documentation

The contractor shall prepare and submit documentation in accordance with the applicable portions of section 3.6 of the AOSO Specification X-623-63-136. In case of conflict, this document takes precedence. The contract shall contain a Schedule delineating documentation to be submitted in accordance with the following requirements:

(A) Informal weekly memo progress reports.

(B) Bi-monthly progress reports.

(C) One final report.

(D) Test plans, procedures, and reports for all tests specified in this document.

(E) Updated specifications for all subsystems.

(F) Updated plans to be issued as specified in the contract Schedule for Items 7, 9, 10, 11, 12, 13, 15, 16, 17, and 18 of Article IX and X (Schedule) of NAS5-3587, dated 30 April 1964.

(G) Topical reports specifically identified in the contract.

(H) Updated Experiment Requirements Specification.

(I) An informational copy of all technical documents (technical letters, memos and reports) generated at RAC SSD, and those submitted to RAC SSD by RAC EPD, Honeywell, Inc. and Texas Instruments.

(J) A list will be prepared by the end of Phase IA of all deliverable formal reports (contract items) and other formal report documents submitted during Phase I and IA showing the date of original submittal and applicable up-dating references.

2.7 Meetings

The following formal technical and management meetings shall be held during the Phase IA program:

(A) Management Meeting during the 1st month.

(B) Experimenters meeting on January 13th and 14th, 1965 at GSFC.

(C) Systems meeting, including detailed review of subsystems during the 3rd month at GSFC.

(D) A meeting at RAC during the 4th month to include all activity at RAC, including management.

(E) Stabilization and control subsystem meeting at Minneapolis during the 5th month, including SCS AGE and GOE.

(F) Communications and data handling subsystem meeting at Dallas during the 5th month, including CDHS AGE and GOE.

(G) Informal systems, subsystems and experiment meetings - In general, there will be four (4) informal meetings held per subsystem (including AGE and GOE) during Phase IA. The meetings will be held on a monthly basis and will not be held on the months when a formal meeting is held in the same subsystem.

The timing of the above meetings is based on contractural (not calendar) months.

2.8 Reliability Program

2.8.1 Reliability Assurance Program Plan

The contractor shall review the updated Phase I RAPP with NASA personnel to assure coverage of all areas and for the additions of elements which would improve the AOSO reliability effort.

The following tasks are required by all participating groups in accordance with the Reliability Assurance Program Plan. Results of these efforts will be included in periodic reports, or topical memo reports as shown.

(A) Update and submit as memo reports the Parts and Materials Actual Usage List, and Preferred Parts List. This will define for each part:

Function, i.e., resistor, choke, etc.
Identification, i.e., rating mfr. model number, etc.
Approved source
Environment and specific location
Applicable specification(s)
Special qualification, if required, and schedule
Parts Failure Rate
Flow time, order to delivery
Price

(B) Prepare a Preliminary Process Specification List. Submit as memo report.

(C) Continue review of TR's and TIR's. Report in periodicals.

(D) Monitor equipment and test log entries. Report in periodicals.

(E) Report reliability activity in all periodic reports.

(F) Update the Reliability Prediction Model and make reliability predictions. Report in a memorandum report or letter.

(G) Update failure effects data as required for updating reliability model. Suggest areas for reliability improvement as a result of the predictions.

(H) Review all test plans and procedures and reports.

(I) Monitor tests as required.

(J) Review all subsystem and assembly specifications.

2.8.2 Separate Reliability Costs

A separate reliability cost package will be established for each subsystem and associated with the following task numbers:

2.8.2.1 Stabilization and Control Subsystem (SCS) Reliability

3.0 OBSERVATORY REQUIREMENTS

Paragraphs 3.1 through 3.6, which were Phase I tasks, have been deleted from this document. All incomplete, continuing, and associated effort from Phase I has been rewritten into the Phase IA tasks given herein.

3.7 Systems Engineering

The contractor shall conduct technical systems management and systems engineering effort on a continuing basis as required for the design, development, test, and pre-prototype manufacture of the AOSO. This responsibility shall include, but not be limited to, systems trade-off studies considering scientific requirements, operational versatility, weight, reliability, cost, and schedule. The effort shall be broad enough in scope to encompass such areas as alternate or parallel approaches to experiment support structure, growth studies, and launch vehicle selection. Part of this systems effort is to be directed by specific GSFC requests, which will be issued as systems decisions as required. When alternate approaches or design changes may be advantageous to the project, the contractor shall notify GSFC and submit their recommendations and complete supporting data.

Specific initial tasks assigned to the systems engineering effort follow:

3.7.1 Status Monitoring

A comprehensive study shall be made of the status telemetry requirements of the observatory. Based on this study, the subsystems status monitoring points shall be reviewed to determine if they satisfy these requirements and recommendations made on how unsatisfied, and/or poorly satisfied requirements, can be met. The tie-in with observatory operations and instrumentation for observatory status monitoring shall be defined. Results of this effort shall be documented in memoranda reports.

3.7.2 Errors

Error sources shall be identified and the error analysis shall be continued. Comparison with mission and experimenter requirements shall be used as criteria in these analyses. Results will be documented in a separate section of periodic reports.

3.7.3 Disturbances

The effects of disturbance forces and torques on the system performance shall be initially updated by a memo report and changes will be documented in periodic reports.

3.7.4 Observatory Separation Interface

Design work shall be initiated on the observatory portion of the separation interface. Particular attention shall be given to the electrical separation connector, the generation within the observatory of a separation signal, and the observatory requirements for Agena telemetry. Results will be documented in periodic reports.

3.7.5 Design Criteria

The following documents shall be reviewed and the results documented in periodic reports:

(A) Design Practices Manual (Report RAC-762-55A).

(B) General Environmental and Test Specification (RAC Report AOSO R17-11).

(C) General Electromagnetic Interference Control Design and Test Specification (RAC Report AOSO R17-21).

(D) Magnetic Interference Torque Component Specification (RAC Report AOSO R17-36).

3.7.6 Interface Requirements

The preparation of Interface Control Documents (ICDs) shall be initiated in accordance with the Interface Plan RAC 762-20A, dated 18 May 1964. A complete list of ICDs shall be prepared which will include the status of each ICD, and a mutually agreeable estimated authentication date. Preliminary versions of all Level II ICDs shall be completed prior to the end of Phase IA. A cross check with the preliminary ICDs shall be made and information for further updating of ICDs shall be gathered during all integration tasks in this document. The list shall be supplied in a memorandum report.

3.7.7 Specification Compliance

The contractor shall review all applicable specifications, standards, etc., noted in AOSO Specification X-623-63-136, for the purpose of determining (by paragraph) the extent to which they may apply to the development of AOSO. Where the contractor determines that a specification, or any part of it, does not apply, he shall indicate the extent of the application. The preliminary work in this area has been documented in RAC IOC AOSO-ENG-64-477 of 12 October 1964. The contractor shall submit the results by memo report of these findings to GSFC no later than 17 January 1965. This data shall be used as a basis for further contractor effort during the remaining part of Phase IA to prepare detail revisions and/or new specifications for GSFC approval and contract implementation. A cooperative effort shall be made between RAC and GSFC and all reasonable means must be exercised to resolve conflicting requirements prior to the submission of the report.

3.7.8 Mass Properties Reports

The mass properties digital program developed in Phase I will be utilized to monitor observatory weight in conjunction with Task 3.7.10 below. The values given by the computer program developed in Phase I will be reported to GSFC in a monthly memorandum report (incorporated into the periodic reports when possible) and in a separate quarterly report which includes a full computer printout.

3.7.9 Updated Failure Mode of Operation Study

Revisions to the Failure Mode of Operation Study will be submitted by memorandum report. This will result in recommendations for the standby mode of operation of the system.

3.7.10 Weight Reduction Campaign

A detailed weight reduction study will be conducted encompassing all observatory subsystems. This will include the coordination of experiments and experiment support provisions, the structure and thermal control, power supply, stabilization and control, and communications and data handling subsystems. Regaining a 10 percent weight contingency for the Thrust Augmented Thor-Agena D will be the goal of these studies. Data will be retained as preliminary ICD information. Results will be reported in periodic reports.

3.7.11 Full Sunlight Observatory

A study shall be made to determine the advantages and disadvantages of a "Full Sunlight AOSO". The term "Full Sunlight AOSO" shall refer to an AOSO designed to operate only in full sunlight. This implies a maximum life of approximately 9 months and a minimum life dependent on launch conditions. The study effort shall be reported in a memorandum report which shall include but not be limited to the following topics:

(A) A discussion of the effect of launch date versus time in full sunlight. (This work has already been done, but a reprint should be included here for information purposes.)

(B) A discussion of the changes in the design of the present observatory which would be possible if only full sunlight orbits were considered. This should be broken down into subsystems and assemblies with particular attention given to changes in redundancy and complexity.

(C) A discussion of the observatory system giving weight and power estimates along with new capabilities and or limitation for the experiments.

(D) A budgetary estimate of the new observatory cost.

3.8 Experiment Coordination

The activities of various groups within Republic, and Republic's subcontractors will be monitored, and information and support will be provided to these groups relative to experiments and experiment arrays. Compatibility between experiments and spacecraft will be insured through liaison between GSFC and the experimenters, and by supplying experimenters with updated test and study results. The following tasks shall be accomplished by the contractor regardless of where, or by whom, the actual task of experiment integration is performed.

3.8.1 Experimenter Meetings

The contractor shall maintain liaison with all AOSO experimenters and their subcontractors during Phase IA through the GSFC Experiment Manager. This will include correspondence, telephone contact, and one or two meetings with each experimenter.

3.8.2 Experimenter Documentation

The following documentation will be provided:

(A) Experiment Integration Plan - The Experiment Integration Plan will be revised and rewritten as a memo report suitable for distribution to the experimenters through the GSFC Experiment Manager. Only the branch plan mutually agreed upon between GSFC and Republic shall be described. The required document will be submitted to GSFC as a reproducible transparency as soon as feasible after the appropriate branch plan has been selected, but in no case shall this submittal be made prior to the third month of the Phase IA program.

(B) Experiment Requirements Specification - The Experiment Requirements Specification will be revised, as required. Reproducible transparencies of revisions shall be supplied to GSFC.

(C) Special Interpretive Reports will be generated from time to time, as required, explaining and analyzing in depth the impact of certain spacecraft and operational characteristics on the performance of the various experiments. These reports will be developed primarily for experimenter use, and shall be coordinated with GSFC.

3.8.3 Experiment Requirements

The experiment coordination effort will be supported by the contractor's engineering effort in a number of specific tasks as detailed in the following:

3.8.3.1 Experiment Power Switch Requirements - The experiment power switch requirements will be determined by the experiment coordination group. Results shall be included in periodic reports, and prepared for inclusion in an experimenter's bulletin.

3.8.3.2 Experiment Compartment Configuration - An experiment compartment configuration study will continue throughout Phase IA. During this study, standard design approaches for AOSO experiment installations will be defined wherever possible. Standards may be possible in:

Mounting and alignment hardware.
Thermal design, and environment protection in general.
Grounding, RFI, Fault Protection, etc.

Since standardization has limitations, detailed studies will be undertaken of the installation of each individual experiment. Experiment priorities and the extent of these individual studies will be coordinated with the GSFC. These studies will result in (1) specific inputs to experiment documentation, paragraph 3.8.2 above; (2) detailed dummy experiment package drawings; (3) layout drawings for three different experiment instrument arrays; (4) access requirements; and, (5) inputs for the observatory mass properties calculations. Progress will be reported in an initial memorandum report and in periodic reports.

3.9 <u>Configuration Development</u>

The observatory/spacecraft design will be iterated during Phase IA considering the items listed below. This will result in a revised partial set of configuration definition drawings. Progress will be noted in periodic reports.

3.9.1 Solar Array

A structural/mechanical design layout drawing of the solar paddle and the solar paddle array shall be made. A positive knee brace lock shall be included in the design. The layout should be carried out with sufficient detail to permit a weight, stress and dynamic analysis. Design a solar paddle retention and preload mechanism utilizing a nonmetallic tensioning cable (no turnbuckle). The cable shall be severed in two places by redundant pyrotechnic devices; either severing will release the cable completely. Study the effects of the magnetometer installation on the paddle dynamic response and provide mass balance as required.

Study the installation requirements of all components and wiring on the paddles. Study in particular wire harness ingress to the thermal housing at the solar paddle hinge and its effects upon paddle deployment. Select electrical and RF connectors to satisfy all requirements. Design a wiring harness suitable to meet these requirements.

The mechanical, structural, thermal and electrical interfaces of all components of the solar array and the array itself shall be established as preliminary ICD information. Results will be reported in periodic reports and a single layout drawing.

3.9.2 Equipment Compartment

Layout the equipment compartment and its structural arrangement to accommodate the existing components and provide growth capability. Candidates for particular attention shall be:

(A) Larger inertia wheels.

(B) Larger narrowband package.

(C) Larger power conversion and control packages.

(D) Magnetic torque logic package.

(E) RFI filter and junction box.

(F) Tape recorder.

(G) N_2 system installation (relocate tanks).

(H) Magnetic torque bars or coils.

The mechanical, structural, and thermal preliminary interfaces of all the packages of the CDHS, SCS, and PSS shall be established during this phase. This layout shall be reviewed by all responsible disciplines and serve as the basis for the preparation (during Phase II) of engineering drawings for manufacture of the functional prototype and flight vehicles. Results of this task will be documented in periodic reports.

3.9.3 Observatory Cabling

Prepare a comprehensive wiring diagram of the spacecraft and experiment package. This shall include wire count, pin and connector allocations, and signal characteristics.

Update the electrical block diagram of the spacecraft subsystems.

Define the requirements for wire types which are suitable for the AOSO environment. In addition, consideration shall be given to required wire size, insulation materials, abrasive resistance, dielectric strength, outgassing properties, shielding, and RFI requirements as well as solderability and stripability. Strength, IR drop and weight shall also be considered in the final choice of wire. The aforementioned requirements shall be discussed with each of the subsystem vendors to ascertain the suitability of the selected wire to the particular subsystem and its over-all compatibility with the observatory requirements.

The choice of electrical connector shall be finalized with each of the subsystem contractors. The connectors shall be chosen on the basis of suitability for the AOSO environment, electrical function, mechanical characteristics.

On the basis of the above tasks, design an electrical spacecraft harness. Consideration shall be given to optimum routing of the harness for minimum weight, shortest lead lengths, sufficient mechanical and structural strength,and minimum magnetic fields. Report results periodically.

3.10 Alignment Test Planning and Facilities Review

3.10.1 Alignment and Calibration Requirements and Techniques

3.10.1.1 Alignment Instrumentation - Alignment development tests on the 100-inch experiment support tube detailed in Task 4.1.22.2 below, will be closely monitored and the performance of the support tube and of the alignment instrumentation will be evaluated. Alignment instrumentation which includes mirrors, gravity reference devices, autocollimators, optical elements, etc., shall be extensively reviewed and recommendations submitted in a memorandum report.

3.10.1.2 Alignemtn Plan - The alignment plan and related documents prepared during Phase I will be updated by memorandum report, utilizing the latest information available from the experimenters and Honeywell, and incorporating the results of Republic alignment tests. The updated alignment plan, memorandum report, shall be delivered to GSFC and the approved version shall represent the definitive plan to be utilized during Phase II.

3.10.2 Facilities Review

A study shall be made to determine and justify the AOSO spacecraft and experiment requirements for still room, clean room, and alignment facilities. After the requirements have been established, a review of the RAC, GSFC, and PMR facilities shall be made to determine what is needed to make those facilities adequate for AOSO. Results shall be reported by memorandum or letter reports.

4.0 SUBSYSTEMS REQUIREMENTS

4.1 Structure and Thermal Control Subsystem (STCS)

Paragraphs 4.1.1 through 4.1.17, which were Phase I tasks, have been deleted from this document. All incomplete, continuing, and associated effort from Phase I has been rewritten into the Phase IA tasks given herein.

4.1.18 Thermal Analysis Program Development

The program shall be utilized to determine the required thermal design parameters and material properties which minimize internal and external temperature excursions of the observatory during pre-launch, launch, and orbit environments. The program shall be capable of solving three (3) dimensional heat conduction and radiation equations for bodies having arbitrary geometry. In addition, the program shall have the capability of rapid iterations of the observatory thermal balance.

Required <u>input</u> characteristics are as follows:

(A) Observatory incident energy to include:

1. solar radiated
2. earth reflected
3. earth emitted radiated
4. observatory reflected
5. observatory radiated

(B) Configuration factors:

1. observatory to earth
2. observatory to sun
3. observatory to appendages

(C) Observatory geometric factors.

(D) Albedo factor

(E) Internal heat generating sources:

1. Heat dissipation and assumed duty cycle per box.
2. Number and location of boxes.

3. Size and configuration of each box.

4. Aperture area for each experiment box and for the sun sensor.

5. Observatory insulation.

(F) Internal view factors of boxes.

The required program output parameters are as follows:

(A) Incident energy on the observatory per unit area as a function of surface location and time.

(B) Internal and external node point temperatures of observatory boxes to include:

1. Those within the interior volumes of boxes in the experiment package and boxes in the spacecraft subsystem compartment.

2. Those on the exterior surfaces of boxes in experiment package and spacecraft subsystems compartment.

(C) Observatory node point temperatures internal and external as a function of time (to be determined separately for the experiment package and the spacecraft).

Sufficient information shall be generated by the program to give (with a minimum of effort) the following:

I. Energy flow through the face of the heat shield normal to the sun as a function of heat shield aperture area and time.

II. Net heat transfer between the experiment compartment and the spacecraft subsystem compartment as a function of the time.

III. Net thermal energy exchange per unit area of exterior skin and time as a function of skin location on the observatory.

IV. Net heat flow interchange between selected nodal points as a function of time.

Results will be provided in memo reports. These reports must satisfy the requirements of paragraph 3.6.6 of GSFC document X-623-63-136.

4.1.18.1 A subroutine for the nodal program RAC #64K616, developed during Phase I, shall be written to provide for automatic plotting of the temperature response of selected nodes.

4.1.18.2 An improved form factor program "Confac II" released by Air Force System Command (FDL TDR-64-43 - April 1964) which represents the second stage in the development of a general configuration factor computer program which accounts for blockage, will be put into working order by the contractor's computer personnel. This program will replace program #64K610 developed during Phase I. The inputs-outputs shall be identical.

4.1.18.3 A thermal analog computer program shall be used as a rapid design tool (see Task 4.1.19.1) to perform approximate calculations. As background analog program information, the contractor shall consider and review existing programs and analog circuits by investigating sources such as the company library, SHARE library, NASA analog programs, and other organizations. The program shall have the capability of analyzing at least 25 nodal points and shall be a differential equation type program rather than a direct electrical analog. However, electrical analog circuits may be used as part of the main program where necessary. The program shall be flexible in its ability to handle time varying incident radiation, power dissipation, and radiation interchange between nodes.

4.1.19 Thermal Analysis Studies

Parametric studies utilizing the computer programs shall be performed to give:

(A) Surface properties of external observatory surfaces, internal observatory surfaces, and external box surfaces to minimize temperature gradients of critical elements. These properties are:

1. thermal diffusivity

2. solar absorbtivity

3. infrared emissivity

(B) The properties of the thermal barrier between the experiment package and spacecraft subsystem compartments.

The analyses of 4.1.19.1, 4.1.19.2, 4.1.19.3(A), 4.1.19.3(B), 4.1.19.3(C), and 4.1.19.3(D) shall be reported in separate memorandum reports as the work is completed. Any further work in these areas shall be reported periodically.

Perform the following tasks:

4.1.19.1 Complete the calculation of temperature gradients across the support structure after dynamic equilibrium (quasi-equilibrium) has been reached. The initial temperature near quasi-equilibrium conditions and the number of orbits required to reach this equilibrium shall be determined by using the analog design tool (see Task 4.1.18.3) or by mutual agreement (if necessary).

4.1.19.2 Initiate coupled analysis on spacecraft subsystem compartment. Thermal coating requirements for redesigned equipment packages will be determined.

4.1.19.3 Complete the calculations of the coupled thermal model.

(A) Determine the observatory temperature history for the winter orbit, summer orbit and launch conditions. The temperature histories shall be determined for each of the above orbit conditions on the respective solstice orbit date.

(B) Determine optimum surface properties for experiment thermal housing. Make use of the analog design tool (4.1.18.3) for the initial analysis. Particular attention will be given to assessing the effect that housing properties have on the desired temperature gradients across the support tube (see Task 4.1.20.B).

(C) Determine the temperature distributions on the support tube as a function of experiment configuration and power duty cycle and further define mounting requirements to inhibit heat leakage to the tube. The experiment configuration and duty cycle to be used shall be determined by mutual agreement.

(D) Determine the spacecraft subsystem compartment temperature history with an aft bulkhead for the compartment. The study is to be conducted for the worst case from the standpoint of performance during normal and failure modes of operation.

4.1.19.4 Provide thermal design support to the RAC engineering design group. Use shall be made of the analog design tool of Task 4.1.18.3 and the digital programs of Tasks 4.1.18.1 and 4.1.18.2. This effort is to be costed in those work packages which require supporting effort.

4.1.20 Thermal Distortion Studies

These studies shall contribute to the determination of the allowable distortion to maintain over-all observatory pointing accuracy. Analytical studies to determine the thermal distortion of the experiment support structure vs. temperature gradients across the structure shall be performed. These studies shall take into account experiment boxes of various lengths, and distances between the mounting points on the experiment support structure.

4.1.20.1 Program Generation - Prepare a digital program for the thermal distortion analysis of the experiment support assembly and critically aligned sensors and experiments attached thereon. The program shall be written on the basis of the analytical solutions prepared in Phase I, updated, and extended to cover the following:

(A) Idealizations of the specific experiments, and experiment arrays proposed for simulation. This will include reasonable idealizations for the local support mounts presently conceived for each experiment.

(B) Inclusion of temperature parameters into the formulations to cover the range and type of temperature variations determined to be applicable.

The outputs of the program shall be linear and angular distortions (absolute and relative values) at discrete points along the experiment support tube and experiments. The program writeup shall be provided in a formal report. This report must satisfy the requirements of paragraph 3.6.6 of GSFC document X-623-63-136 and shall include a FORTRAN listing, FORTRAN and binary card decks, and a complete sample printout.

4.1.20.2 Analyses - Employ the program prepared under Task 4.1.20.1 to obtain the following information:

(A) Demonstrate with reasonable accuracy the ability of the experiment support tube to maintain the required pointing accuracies apportioned to each experiment and sensor.

(B) Determine limits on temperature excursions and thermal gradients along the support structure, experiment packages, and sensors necessary to hold distortions of all within their specified limits. This will be determined by analysis of data generated from (A) above.

(C) Generate parametric curve plots for selecting the optimum mounting scheme and placement of each experiment package and sensor.

Results shall be submitted in a separate memorandum report and updated periodically. The results of these analyses shall be employed in the performance of Task 4.1.22 of this document.

4.1.21 Materials Application

Materials application studies will be performed to ascertain the reliable performance of all materials and coatings used in the orbital environment. A study of the combined environmental effects on the material and the effects of released products of these degradations on nearby materials and equipment will be made. Important physical properties of applicable materials will be examined including such properties as thermal expansion, thermal conductivity, emissivity, outgassing, sublimation, solar absorptivity, radiation resistance (UV and nuclear), magnetic susceptibility, electrical, cold welding characteristics, lubricity, and/or any other appropriate characteristic pertinent to the usage.

Review of all drawings, including the contractor's, Texas Instruments' and Honeywell's, will be performed.

Materials requiring further investigation will be determined and literature evaluations begun. Consultation, coordination, and design review of materials usage will continue.

4.1.22 Experiment Support Structure Development

The experiment support structure development effort shall consist of thermal distortion and alignment tests and design studies of an alternate design.

4.1.22.1 Thermal Distortion Test (60-inch structure) - Thermal distortion tests shall be conducted on the experiment support structure to verify and/or modify the parametric curves analytically obtained in Phase I analytical work. The tests are to be conducted under laboratory environmental conditions with temperature gradients across and along the support structure being varied in magnitude and position. As the temperature gradients are varied, a sufficient number of deflection measurements shall be made along the entire length of the structure to determine the actual thermal distortion characteristics of the experiment support structure.

Tests on the 60-inch experiment tube and dummy experiment boxes initiated in the Phase I program will be completed. These tests will be performed in accordance with the informal test procedure plan (RAC document AOSO R17-13A). The experimental data will be compared with the theoretical analysis. Results will be provided in a memorandum test report.

4.1.22.2 Alignment Test (100-inch structure) - The specific goal of this test is to demonstrate an adequate initial alignment procedure on the 100 inch structure built during Phase I. The primary factor involved in the evaluation of the design adequacy of the experiment support structure is the accurate maintenance of the relative alignment between the optical axes of the fine sun sensor and the different experiment instrument packages during the orbital life of the observatory (see 4.1.22.1 and 4.1.22.3). This test must account for the complete structure joining the fine sun sensor and instrument boxes including all mounting brackets, adjustment mechanisms, and the basic experiment support structure.

Alignment tests shall be performed on the 100-inch experiment support utilizing the three existing dummy experiment instrument packages, namely for: (1) Goddard x-ray, (2) NRL spectroheliograph, and (3) High Altitude Observatory coronagraph experiments. The support and experiment boxes will be instrumented to record temperatures, strains (both twist and linear expansion) and distortion data. The technique proposed for the alignment test is defined in RAC 762-45. The general test plan is given in RAC 762-17. Detailed test procedures (informal format) shall be submitted at least two weeks prior to the start of the test. A study will be made of alternate methods and equipment to perform the alignment of the critical experiments and fine sun sensor (see Task 3.10.1.1, this document) in case the existing method and/or equipment is not adequate. Results will be provided in a memorandum test report.

4.1.22.3 Thermal Distortion Test (100-inch structure) - The 100-inch experiment support and dummy experiment boxes will be tested to confirm the thermal distortion analysis. The support and experiment boxes will be instrumented to obtain temperatures, strain (both twist and linear expansion) and distortion data. A controllable conductive heating source shall be used to provide the temperature gradients on the experiment structure and the experiment boxes. Several test conditions consisting of both predicted and overstressed thermal gradients shall be applied to the experiment structure and the instrumented data recorded. A detailed test procedure (informal format), similar to that used for Task 4.1.22.1 shall be submitted at least two weeks prior to the start of the test. This experimental data shall be compared with the theoretical analysis of Task 4.1.20.2 above. Results will be provided in a memorandum test report.

4.1.22.4 Alternate Support Structure Design Studies - As a backup to the present 100-inch support design, studies will be conducted of alternate means of providing experiment support in case the present design does not prove to be adequate. These studies will be oriented towards the latest experiment instrument configurations and will consider means of increasing support stiffness and area moment of inertia, so as to reduce the thermal distortion sensitivity of the support and experiment mounts. As a minimum, a conceptual design layout drawing of a new structure, employing the results of Task 4.1.20.2, shall be submitted. Design calculations and study results shall be submitted in periodic reports.

4.1.23 STCS Reliability

Reliability effort for the Structure and Thermal Control Subsystem shall be performed as per Task 2.8.1 and costed in accordance with Task 2.8.2.

4.2 Stabilization and Control Subsystem (SCS)

Paragraphs 4.2.1 through 4.2.15, which were Phase I tasks, have been deleted from this document. All incomplete, continuing, and associated effort from Phase I has been rewritten into the Phase IA tasks given herein.

The contractor shall provide the necessary resources and material for the design, fabrication, and test of the SCS and its associated AGE. One of the objectives of Phase IA will be to show feasibility through hardware demonstration of the control subsystem as presently designed.

The SCS and associated AGE referred to herein consists of the following:

(A) Stabilization and Control Subsystem

1. Inertial Reference Packages (Roll, Pitch, Yaw) (DGG269A1) (IRP)
2. Fine Sun Sensor (DLG88A1) (FSS)
3. Electronics Control Assembly (DEG227A1) (ECA)
4. Digital Electronics Assembly (DBG226A1) (DEA)
5. Inertia Wheels (Roll, Pitch, Yaw) (DAG60A1, DAG71A1, DAG72A1) (IW)
6. Reaction Jet Assembly (DAG119A1) (RJA)
7. Star Tracker (DKG86A1) (ST)
8. Coarse Acquisition Sun Sensor (DLG87A1) (CASS)
9. Magnetic Torquing Assembly (MTA)
10. Medium Sun Sensor (MSS)

(B) Aerospace Groune Equipment (AGE)

1. Assembly Test Stations
   (a) Control (DUG1812A)
   (b) Optical (DUG1813B)
2. Automatic Analyzer (System Tester) (DUG1810A)
3. Pre-launch Test Panel (DUG1618A)

Where reference is made to "Engineering Model" and "Pre-Production Prototype Model" the definitions are:

(A) Engineering Model - The engineering model is equivalent functionally and performance-wise to the production prototype model but will not necessarily have the same form in all respects where it is desirable to provide access for servicing and modification. Wherever possible MIL standard parts and materials shall be used although non-spec parts and materials may be substituted where necessary in order to conform to schedule requirements.

(B) Pre-Production Prototype Model - The pre-production prototype is equivalent functionally and performance-wise and will have the same form as the production prototype but may reflect an "advanced" production design release.

4.2.16 SCS Tasks

4.2.16.1 The contractor shall perform a three axis air bearing test of the SCS, utilizing Phase I hardware plus available Phase IA hardware, i.e., CASS, MSS, breadboard star tracker, etc.

4.2.16.2 The subsystem technical development specifications and preliminary subsystem engineering specifications shall be updated.

4.2.16.3 Preliminary integration of the SCS with the power supply subsystem shall be accomplished (see Task 4.4.6.3).

4.2.16.4 The contractor shall perform systems engineering for continued Phase I tasks as well as efforts identified with Phase IA, i.e., intra-subsystem interface and system analysis.

4.2.16.5 Integration Test - The contractor shall complete the bench integration tests using the FSS with the other units of the SCS.

4.2.17 Fine Sun Sensor

4.2.17.1 Design - The design and development started in Phase I shall be continued toward the design release of the pre-production prototype electronics and optical-mechanical packages, including completion of the engineering and procurement specifications, electronic module and chassis parts packaging to achieve required form factor and electrical noise attenuation. The present life testing of the fine wedge drive shall be continued and periodically evaluated. Design evaluation and engineering proof testing, using the hardware produced in Phase I shall be completed.

4.2.17.2 Performance Tests - The contractor shall perform those tests, including thermal-vacuum and vibration tests, required to demonstrate the feasibility of the FSS design to meet the specified performance. The differential pressure concept shall be evaluated in these tests.

4.2.17.3 FSS Reliability Improvements - The following FSS studies and test shall be performed:

(A) A study to improve the reliability of the wedge readouts. Such techniques as the use of different detector(s) shall be investigated.

(B) A trade-off study between the present case design and a sealed unit which maintains a positive pressure.

(C) Perform reliability tests of the FSS wedge drive subassembly utilizing ten (10) stepper motors and an appropriate number of fine wedge drives. The objective of these tests is to gather engineering data in order to:

1. Assure that the fine wedge subassembly will perform as required under all environmental conditions demanded by the SCS qualification tests.

2. Uncover Q. C. defects that can be anticipated and develop screening techniques.

3. Discover modes of failure.

4. Evaluate the fine wedge subassembly life to assure that it is adequate for the AOSO mission.

Particular attention during these tests shall be given to determining if acceptable backlash limits can be maintained. The evaluation of alternative lubricants on the wedge drives is required.

Following is what GSFC considers to be a reasonable life test. The fine wedge drives shall be incorporated into this test as appropriate to achieve the above stated objectives. Exact values for length of test and pulse rates shall be chosen by the contractor:

Life Test

Life - 1 1/2 years minimum for 10 motors passing environmental tests; at rated voltage and approximate AOSO load conditions and "room" temperature and pressure conditions.

(a) Two motors to be driven at 300 pulses per second with motor shafts differentially connected so that differential output shaft will always be a zero position to check for skipped or double steps.

(b) Two motors to be driven at 100 pulses per second with motor shafts differentially connected so that differential output shaft will always be at zero position to check for skipped or double steps.

(c) Two motors driven at 300 pulses per second by a symmetrical and zero average value wave so that motor shaft will always be within 1 step of zero position for skipped or double steps in either direction.

(d) Two motors driven at 100 pulses per second by a symmetrical and zero average value wave so that motor shaft will always be within 1 step of zero position for skipped or double steps in either direction.

(e) Two motors driven at 300 pulses per second with symmetrical and zero average value wave so that motor shaft will always be within 1 step of zero position for skipped or double steps in either direction. The motors to be run for 1 week each month for the 1 1/2 year period to check for failure modes at low duty cycles.

4.2.17.4 FSS Fabrication - Modification of the Phase I breadboard will be accomplished to incorporate changes which the test results of Task 4.2.17.2 and studies indicate are necessary or desirable before meaningful design data can be obtained for the production design. In addition, parts and subassemblies will be fabricated to update the Phase I engineering model optical-mechanical package to a pre-production prototype non-redundant configuration.

4.2.18 Electronic Control Assembly

4.2.18.1 Design - The design and development started in Phase I shall be continued toward the production design release, including completion of the engineering and procurement specifications and continuation of the bench testing to define shielding and grounding requirements and necessary modifications of critical subassemblies to provide basis for the production design.

4.2.18.2 Fabrication - Fabrication shall be limited to the modification of the Phase I breadboard to incorporate changes which test results indicate are necessary before meaningful results can be obtained on succeeding tests.

4.2.19 Digital Electronic Assembly

4.2.19.1 Design - The design and development started in Phase I shall be continued toward the production design release, including completion of the engineering and procurement specifications and continuation of the bench testing to define shielding and grounding requirements and necessary modifications of critical subassemblies to provide basis for the production design.

4.2.19.2 Fabrication - Fabrication shall be limited to the modification of the Phase I breadboard to incorporate changes which test results indicate are necessary before meaningful results can be obtained on succeeding tests.

4.2.20 Coarse Acquisition Sun Sensor

4.2.20.1 Design - The design and development started in Phase I shall be continued toward the design release of a pre-production prototype, including completion of the engineering and procurement specifications. Design and development of an engineering model CASS (including preparation of drawings), which can be illuminated by a single source for use in subsystem integration tests, shall be completed.

4.2.20.2 Fabrication - Fabrication of one complete engineering model CASS assembly (non-redundant, i.e., 4 solar cell units) shall be completed.

4.2.21 Medium Sun Sensor

4.2.21.1 Design - The design and development started in Phase I shall be continued toward the design release of a pre-production prototype, including completion of the engineering and procurement specifications, the MSS configuration, circuit-schematics, preliminary layout drawings, and mounting and alignment considerations.

4.2.21.2 Fabrication- Fabrication of one complete pre-production prototype MSS assembly (non-redundant, i.e., 2 solar cell units) shall be completed.

4.2.22 Inertia Wheel

4.2.22.1 Design - The design and development started in Phase I shall be continued toward the design release of a pre-production prototype, including completion of the engineering and procurement specifications. Studies shall include optimization of motor design, calculation of motor losses, stiction, friction, windage losses, back EMF, redundancy measures and part failures. Life testing of breadboard brush and bearing assemblies shall be started.

4.2.22.2 Fabrication - Fabrication of one pre-production prototype of each of the yaw and pitch wheels shall be initiated. In addition, a breadboard bearing assembly and brush assembly for life testing shall be fabricated.

4.2.23 Inertial Reference Package

4.2.23.1 Gyro Selection Study - Gyro package configuration studies as outlined in TD-8 will be conducted.

4.2.23.2 Design - Based on the results of Phase I and 4.2.23.1, the design and development of the roll, pitch, and yaw IRP shall continue toward design release of the pre-production prototype. Included shall be completion of the gyro Technical Development Specification, and engineering and procurement specifications. The necessary thermal and mechanical studies for installation will be conducted to assure a satisfactory interface with the spacecraft. Breadboard testing shall be conducted.

4.2.23.3 Fabrication - Fabrication of one non-redundant engineering model of an IRP, and one GG159 gyro for this IRP, shall be initiated.

4.2.24 Star Tracker

4.2.24.1 Design - The design and development of the ST will be started in Phase IA and continue through the design release of an engineering model which would not include the movable gimbal, sun protection assembly, and pre-production configuration for the cards and modules. Breadboard testing shall be conducted to permit evaluation of parameters such as field of view, linearity, background noise sensitivity, star level sensing, and performance capability. The design effort will be continued towards completion of the design release of the pre-production prototype. Necessary thermal-mechanical studies will be conducted to ensure satisfactory interface with the spacecraft.

4.2.24.2 Fabrication - Fabrication of one non-redundant engineering model star tracker design shall be completed.

4.2.25 Magnetic Torquing Assembly

4.2.25.1 Design - The design and development of the MTA will be started in Phase IA and continued toward completion of the pre-production prototype. This effort shall include studies of magnetic torquing, bar torquing capability, optimum package location, alignment tolerances of components, and preliminary layouts and schematics to determine size, weight, and power. The studies shall include a computer simulation of the assembly to show feasibility of operation and adequate performance in the SCS.

4.2.25.2 Fabrication - Breadboards of the critical circuits of the magnetic unloading assembly shall be fabricated and tests initiated.

4.2.26 AGE Design and Development

The results of this effort shall be presented in the periodic reports, drawings and specifications.

4.2.26.1 AGE Systems Design - The contractor shall provide the services and materials to continue the AGE systems engineering started in Phase I as well as efforts identified with Phase IA, including the definition of assembly test points, and test procedures, preparation of the preliminary automatic checkout programs and the coordination necessary to insure compatibility with the automatic observatory checkout concept and equipment.

4.2.26.2 Design and Development of the Assembly Test Stations (DUG1812A and DUG1813A) - The contractor shall provide the services and materials necessary toward design and development of the assembly test station and preparation of the test development specification for each of the test stations.

4.2.26.3 Design and Development of the Automatic Analyzer (DUG1810A) - The contractor shall provide the services and materials necessary toward design and development of the automatic analyzer and preparation of the test development specification.

4.2.27 Flexible Body-Control Loop Coupling Studies

The contractor shall continue investigations and simulations of structural-control loop coupling, including the effects of relative motion between the FSS mounting point on the experiment support structure and the SCS actuators as a result of internal disturbance torques generated by the spacecraft subsystems in orbit. The flexible body analysis must include the effect of ball joint tolerance.

4.2.28 SCS Reliability

Reliability efforts in support of paragraph 2.8.1 shall be costed in accordance with paragraph 2.8.2.

4.2.29 Reports

Periodic reports shall contain the results of the efforts of Tasks No. 4.2.16.2, 4.2.16.3, 4.2.16.4, 4.2.17.1, 4.2.17.2, 4.2.17.4, 4.2.18, 4.2.19, 4.2.20, 4.2.21, 4.2.22, 4.2.24, 4.2.25, 4.2.26, and 4.2.28

Separate memorandum reports shall be submitted for Tasks 4.2.16.1, 4.2.16.5, 4.2.17.3, and 4.2.27.

A separate memorandum report with periodic updating shall be submitted for Task No. 4.2.23.

4.3 Communications and Data Handling Subsystem (CDHS)

Paragraphs 4.3 through 4.3.6 which were Phase I tasks, have been deleted from this document. All incomplete, continuing, and associated effort from Phase I has been rewritten into the Phase IA tasks given herein.

The contractor shall supply the necessary resources, materials, and subcontract monitoring for the design, fabrication, and test effort associated with the CDHS tasks described below.

4.3.7 CDHS Breadboard

The breadboard shall consist of:

(A) Pan 101

One non-redundant system timing assembly.
One non-redundant PCM decoder subassembly.
One non-redundant command programmer subassembly.
One non-redundant CRU subassembly.
Digital signal conditioning - (40 bits).

(B) Pan 104

One narrowband data handling subassembly - 250 channels.

(C) Pan 105

One wideband data handling subassembly.
One non-redundant ADC subassembly.
One data storage logic unit.
One data transmission logic unit.
Digital signal conditioning - 8 bits.

(D) Pan 106

One command memory unit.

(E) One wideband memory unit.

(F) One tape recorder unit (customer furnished equipment).

The contractor shall complete the assembly and testing of the CDHS breadboard fabricated in Phase I. This shall include:

4.3.7.1 Install equipment in pans (task initiated in Phase I).

4.3.7.2 Pan tests and subsystem tests:

(A) Electrical tests (task initiated in Phase I).

(B) Limited environment tests (new task).

1. thermal

2. vibration

(C) Preliminary RFI tests (new task).

4.3.7.3 Make changes as required due to possible design and fabrication errors, etc., and update Phase I breadboard drawings to reflect changes resulting from tests (new task).

4.3.7.4 Test and integration of one GFE recorder. The results of this effort will be summarized in the test reports (task initiated in Phase I).

4.3.8 CDHS Prototype Design

The objective of this effort is to work toward the completion of the CDHS prototype design which shall include the specifications and engineering drawings necessary for the fabrication of all subsystem prototype hardware anticipated to be scheduled in Phase II.

4.3.8.1 Design and Engineering Tasks - The contractor's effort shall be directed to meet these requirements and shall specifically include the following:

The contractor shall provide the effort necessary to refine the CDHS electrical logic design based upon current design, fabrication, and test results. This effort shall also include the redesign of items not included in the breadboard configuration but which have been previously outlined as requirements, i.e., two-mode data transmission operation, command programmer counter signals, etc.

4.3.8.2 Drawings and Layouts - The contractor shall provide the services necessary to update the Phase I drawings and layouts and prepare new drawings, as required to meet the objective stated in paragraph 4.3.8. This effort shall include, but not be limited to, the preparation of subsystem, assembly, and subassembly block diagrams and detail functional schematics to include the necessary logic detail and equations for signal tracing. The diagrams and schematics shall be prepared such that a complete assembly (i.e., all items of the command assembly) is shown as a complete schematic with interfaces (including signal parameters).

4.3.8.3 Specifications - The contractor shall provide the services necessary to update Phase I specifications and the preparation of new specifications, i.e., signal conditioner, etc., to meet paragraph 4.3.8 requirements.

4.3.8.4 Packaging Concept - The contractor shall provide the engineering services to refine the CDHS packaging concept in conjunction with tasks included in paragraph 3.9.2. This task shall specifically include consideration for enlarging pan sizes, as required, (particularly Pan 101) in order to reduce the number of external test connections to the extent allowable within the refined observatory compartment configuration.

4.3.8.5 Complete Vendor Prototype Design - The contractor shall provide the design, engineering and procurement services to finalize the requirements, select vendors, and complete vendor design and engineering effort for items deleted during Phase I to meet the requirements of paragraph 4.3.8. This requirement specifically includes the following items:

(A) Receiving equipment

(B) Tape recorders

(C) Transmitters (VHF and UHF)

(D) Tone decoders

4.3.8.6 Antennas - The contractor shall provide engineering effort on the UHF and VHF antenna systems. He shall also analyze and evaluate the contour plots of the systems, as mounted on the spacecraft, against the AOSO ephemeries and the selected ground stations. The results of this effort shall be documented in a memorandum report.

4.3.8.7 AGE

4.3.8.7.1 Assembly Test Equipment - The contractor shall provide the resources necessary towards the design of assembly test equipment. This effort shall include:

(A) Electrical design to the logic design level.

(B) Mechanical design sufficient to size the individual drawers and racks and to lay out the front panels (controls, indicators, etc.).

(C) Preliminary drawings (engineering sketches to the detail level indicated above.

(D) Equipment and procurement specifications.

(E) Breadboard unique circuits other than standard logic cards.

4.3.8.7.2 Computer-Automated AGE - The analysis of Computer-Automated AGE requirements started in Phase I shall continue. Emphasis shall be placed on firming the following:

(A) Update subsystem AGE requirements.

(B) Define subsystem tests to be performed with the Computer-Automated subsystem AGE.

(C) Identify and define requirements of each of the major units of the subsystem AGE.

(D) Define detail interfaces between subsystem AGE and the computer.

(E) Physical layout of the AGE.

4.3.9 General Task Support

The following efforts applicable to the CDHS will be provided to support general tasks described elsewhere in this Work Statement as noted below:

4.3.9.1 CDHS Reliability (see Task 2.8)

Update Reliability Prediction Model.

Update Parts List (one submittal).

Failure Reporting

Monitor breadboard tests and design changes.

4.3.9.2 Documentation (see Task 2.6)

Progress Reports.

Breadboard test reports.

Updated specifications.

Drawings (see Task 4.3.8.2).

Updated test procedures, as applicable.

Failure Mode of Operation Report (see Task 3.7.9).

Updated operational concepts (one submittal).

Memorandum reports for topical subjects.

4.3.9.4 Systems Engineering (see Task 3.7)

Status monitoring.

Command priority.

Subsystem performance analysis.

Mission compatibility.

Interfacing with other subsystems (includes Task 4.4.6.3).

4.3.9.5 Experiment Coordination (see Task 3.8)

Data handling and command interface.

4.3.9.6 Configuration Refinement (see Task 3.9)

Mass properties.

Equipment compartment layout.

Thermal properties.

Cabling requirements, grounding, etc.

4.3.9.7 AGE (see Task 4.5)

4.4 Power Supply Subsystem (PSS)

Paragraphs 4.4.1 through 4.4.4, which were Phase I tasks, have been deleted from this document. All incomplete, continuing, and associated effort from Phase I has been rewritten into the Phase IA tasks given herein.

4.4.5 Power Supply Subsystem Assemblies

4.4.5.1 Solar Array Assembly - The solar array vendor shall be selected. The solar array design specification prepared in Phase I shall be revised to reflect all design changes. Detail designs of the solar cell module shall be evaluated and coordinated with the substrate design (see Task 3.9.1) to insure thermal, electrical and mechanical compatibility. Solar cell test modules shall be fabricated and made available for testing at Republic at the beginning of Phase II. Preliminary design for the solar cell array AGE shall be prepared. Progress shall be included in the periodic reports.

4.4.5.2 Battery Assembly

4.4.5.2.1 Battery Test Program - This is a continuation of Phase I effort. The contractor shall continue the Phase I battery tests on the two and three electrode batteries. Test plans shall be completed, and three separate test reports submitted in memorandum form for the two electrode nickel cadmium, three electrode nickel cadmium, and silver cadmium battery tests.

4.4.5.2.2 Battery Assembly - A battery vendor shall be selected. A detailed design of the battery assembly shall be prepared emphasizing the mechanical, thermal and electrical interfaces. The battery design specification prepared in Phase I shall be revised to reflect all design changes. Preliminary design for the battery AGE shall be prepared. Progress shall be included in the periodic reports.

4.4.5.3 Power Control Assembly - The fabrication, test, and evaluation of the Phase I power control assembly breadboard shall be completed. This will include integration of the control assembly breadboard with simulated solar array power and simulated loads. A cycling test plan shall be prepared and submitted for approval. The test shall include repetitive charge-discharge cycles to evaluate the battery charger and state-of-charge monitor. Other subassemblies will also be repeatedly tested at elevated temperatures.

A weight and volume reduction study shall be initiated. This effort will include the fabrication of the latest approved modifications, within the authorized level of effort. This task will be limited to fabrication and test of engineering lashup (rough breadboards) hardware, and preliminary prototype packaging design. Only minor modifications, such as the possible replacement of components, will be incorporated in the Phase I breadboard. The Phase IA lashups, integrated with those usable portions of the Phase I power control breadboard, will constitute a working, up-to-date power control assembly. RFI studies shall be conducted. Changes will be coordinated and progress reported periodically. The power control assembly performance specification shall be revised to reflect all approved design changes.

4.4.5.4 Power Conversion Assembly - The fabrication, test, and evaluation of the Phase I power conversion assembly breadboard shall be completed. This will include integration of the conversion assembly breadboard with simulated loads and an appropriate power source.

A weight and volume reduction plan shall be instituted. This effort will include the fabrication of the latest approved conversion assembly subassemblies, within the authorized level of effort. This task will be limited to fabrication and tests of engineering lashup hardware, and preliminary prototype packaging design. Only minor modifications, such as the possible replacement of components will be incorporated in the Phase I breadboard. The Phase IA lashups, integrated with those usable portions of the Phase I power conversion breadboard, will constitute a working, up-to-date power conversion assembly.

Changes will be coordinated and progress reported periodically. The power conversion assembly performance specification shall be revised to reflect all approved design changes.

4.4.6 Power Supply Subsystem Analysis and Integration

4.4.6.1 The contractor shall supply the necessary monitoring of Task 4.4.5 above and the effort necessary to accomplish the tasks listed below.

4.4.6.2 Power Budget - The contractor shall provide the effort necessary to maintain and keep track of the AOSO power budget. The results of this effort shall be reported in periodic reports.

4.4.6.3 Breadboard Integration

Selected critical subassemblies of the updated power conversion assembly breadboard shall be integrated with the CDHS and SCS breadboards independently to determine functional compatibility (see Tasks 4.2.16.3 and 4.3.9.4). The task is a part of the power supply development effort for design validation with test preparation and actual testing limited to a maximum of 2 weeks for each subsystem. This shall take place during the latter part of Phase IA. The test plan and procedures shall be submitted as per 1.3.4 above. Test results will be submitted as a memorandum report.

4.4.6.4 AGE

Efforts in this area will be limited to supplying the necessary technical inputs in support of paragraphs 4.4.5.1 and 4.4.5.2.

4.4.6.5 PSS Reliability

Reliability efforts on the control and conversion assemblies shall be limited to the following:

(A) Update parts and materials actual parts usage list.

(B) Update reliability prediction model.

Reliability efforts in support of 2.8.1 shall be costed in accordance with 2.8.2.

4.5 Aerospace Ground Equipment (AGE)

The analysis of AGE requirements, initiated in the Phase I program will be continued and updated in parallel with the development and design of the observatory and its subsystems. The design of selected equipment shall be initiated.

4.5.1 AGE Design

Contractor shall coordinate the AGE requirements both at Republic and the subcontractors. The AGE requirements will include the restraints imposed upon the design by system functions including reliability of test methods, operating procedures, site limitations or site requirements, fabrication and checkout procedures, etc.

Detailed design requirements will be specified for all AGE including:

4.5.1.1 CDHS assembly, clockhouse, and computer-automated AGE.

4.5.1.2 SCS assembly, blockhouse, and computer-automated AGE.

4.5.1.3 Power subsystem assembly, subsystem, and blockhouse AGE.

4.5.1.4 Automated system AGE (including computer, associated peripherals, software, and van).

4.5.1.5 Antenna AGE

4.5.2 Assembly AGE Design

Design the assembly AGE which is to be delivered in Phase II. This shall include:

4.5.2.1 Electrical design to the logic design level.

4.5.2.2 Mechanical design sufficient to size the individual drawers and racks and to layout the front panels (controls, indicators, etc.)

4.5.2.3 Preliminary drawings (engineering sketches) to the detail level indicated above.

4.5.2.4 Equipment and procurement specifications.

4.5.2.5 Breadboard unique circuits other than standard logic cards.

4.5.3 Computer-Automated Subsystem AGE Design

The analysis of the Computer-Automated Subsystem AGE requirements started in Phase I shall be continued. Emphasis shall be placed on firming the following:

4.5.3.1 Update subsystem AGE requirements.

4.5.3.2 Define subsystem tests to be performed with the Computer-Automated Subsystem AGE.

4.5.3.3 Identify and define requirements of each of the major units of the subsystem AGE.

4.5.3.4 Define interface between subsystem AGE and the computer.

4.5.3.5 Physical layout of the AGE.

4.5.4 Procurement Activities

Compile a list of long lead items. Upon approval by GSFC the contractor shall proceed with either development or procurement of the items.

4.5.5 Mechanical Aerospace Ground Equipment (MAGE) Design

Requirements and layouts shall be prepared for the Mechanical AGE.

4.5.5.1 Ground handling fixture.

4.5.5.2 Hoist sling assembly.

4.5.5.3 Work stands.

4.5.5.4 Special tools.

4.5.5.5 Mass moment of inertia and C. G. fixture.

4.5.5.6 Alignment fixture.

4.5.6 Solar Simulator for Fine Sun Sensor

Efforts shall be initiated for the design and development of an adequate solar simulator to verify fine sun sensor performance. Consideration shall be given to solar simulators presently available or under development. A goal shall be to provide a solar simulator by August 1965.

4.5.7 Reports

Progress on Task 4.5.1 through 4.5.6 shall be submitted in periodic reports.

4.6 Ground Operational Equipment (GOE)

The analyses of GOE and operational requirements undertaken in Phase I shall be continued, expanded, and updated as a result of continuing design. General systems engineering effort will be undertaken to assist the GSFC to formally define the detailed support required from operational control, tracking, data acquisition, ground communications, and data processing systems. Special attention shall be given to defining in detail a Ground Operational Plan (pre-launch, post-launch, and mission routine) and a Support Instrumentation Requirements Plan (SIRP). The effort shall include participation in the meetings listed in Section 2.

Results of the effort shall be reported in two (2) revisions of the Phase I Operational Concepts Related to Ground Systems Report, and updated results shall be included in the Phase IA final report. The first revision, to be submitted one (1) month after the first systems meeting, may be a memorandum report; but must be in the original format; and shall contain 3 new sections dealing with the Ground Operational Plan (listed above), the SIRP (listed above), and a supporting documentation section. The second revision shall be a formal report similar to the reports furnished during Phase I and shall be submitted at the end of the fifth month.